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Book Reviews

Mathematics for the Physical Sciences. By HERBERT S. WILF. Wiley, New York, 1962, 284 pp. $7.95.

Professor Wilf has written a small and valuable book. This 280-page volume is not a text on mathematical physics, and its study will not transform a callow graduate student into a confident "theoretiker." Rather, it presents material drawn from several fields of mathematics, special topics of particular importance to the growing student, and to those who practice mathematical physics "in the modern manner."

The book has seven chapters, entitled "Vector Spaces and Matrices," "Orthogonal Functions," "The Roots of Polynomial Equations," "Asymptotic Expansions," "Ordinary Differential Equations," "Conformal Mapping," and "Extremum Problems." Thus, the student of physics will have to learn about the differential equations of Laplace and Helmholtz, the theories of residues and integral transforms, vector and tensor algebra, etc. from other sources. Each chapter is graced by an annotated bibliography, which encourages the reader to browse in the mathematical literature, and by exercises whose solutions are also given.

Professor Wilf's style of writing is specially fine. It is very clear and manages to be serious and somewhat informal at the same time. While his material is presented as theorem, proof, theorem, proof, . . . the reader has the feeling that epsilonics are being held to a minimum. Almost always, the *idea* of the theorem is stressed, and is summarized, along with the proof.

The material in the chapters is not a restatement of the "same old stuff." Professor Wilf has a special interest in the use of digital computers in mathematics, which is reflected in his choice of topics. In the first chapter, after going through the usual preliminaries, he presents some interesting material on the numerical calculation of eigenvalues and on the properties of matrices with nonnegative elements, those operators so dear to reactor group-theoretikers. The chapter on orthogonal polynomials contains a discussion of Gauss quadrature and introduces the Jacobi matrix, while later chapters include sections on numerical methods for finding roots of polynomial equations, for solving differential equations, and on the construction of algorithms for the solution of extremum problems. Of course, these are not "how to" sections, but rigorous discussions of the numerical methods, which enter naturally into the development of the topic. The author's concern with "understanding before computing" leads him to make a fine sentence, which will be treasured by all members of the society for the Prevention of Computational Outrage. It is that "The blind use of computing machinery (in such cases) can lead only to chaos."

Since the book is short, it is easy for the reader to find topics that should have been included—in his opinion. A short discussion of the zeros of analytic functions other than polynomials would have been most welcome, since one encounters transcendental equations often enough in applied mathematics. Also, the sections on differential equations in the complex plane should be augmented by a short discussion of singularities at infinity. (The corresponding chapter in "Whittaker and Watson" is a model of brevity and clarity.) On the other hand, Wilf's chapters on orthogonal functions and asymptotic series are unusually good, and there is, over-all, a fresh presentation of the subject matter.

One can warmly recommend "Mathematics for the Physical Sciences." Its content and manner of printing make reading it a pleasure. No doubt, also, the price is right.

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(About the Reviewer: Noel Corngold was educated at Columbia College and Harvard University, where he received the Ph.D. degree in physics in 1954. He works at mathematical physics as group leader in theoretical reactor physics at Brookhaven National Laboratory.)

The Theory of Plasma Waves. By T. H. STIX. McGraw-Hill, New York, 1962.

"The literature on plasma waves and instabilities has grown to an impressive size in the last decade, and continues to grow at a frightening rate," to quote the author. The same cannot be said of texts covering this particular subject, so vital to controlled fusion research. The absence of any previous text with a general treatment of this topic would be reason enough to welcome this book. There is even more reason to rejoice in the fact that Dr. Stix's book provides an excellent, well-organized, thorough, and highly-competent treatment of the subject.

The central theme of the book is the linearized Vlasov (or collisionless Boltzmann) equation. This is the basic equation governing the motion of fully ionized hot plasmas, which have now become available experimentally in the controlled fusion program here on earth and have always been available in extraterrestrial situations. The equation may also be applied, with rather simple corrections, to the ionosphere.

The Vlasov equation may be simple, but the range of possible modes of oscillation of a plasma it allows is bewilderingly complex, especially when one immerses the plasma in external magnetic and electric fields and considers streaming of electron or ion beams through the plasma. The author carefully unravels the confusion by proceeding from the simple to the complex. The initial chapter contains a general discussion of waves, introducing the concept of the wave-normal surface and the bounding surface in parameter space. The dielectric tensor is defined and evaluated in the cold-plasma approximation (i.e., for a fully ionized plasma in which the zero-order thermal motions may be neglected) and the corresponding dispersion relation evaluated. Chapter 2 contains a thorough discussion of the Clemmow-Mullaly-Allis Diagram while Chapter 3 discusses energy flow and accessibility of a resonant region in an inhomogeneous plasma. Some instabilities of bounded plasma are the topic of Chapter 4, while Chapter 5 covers free and forced oscillations of a cold cylindrical plasma. The transition to discussion of hot plasmas proceeds through plasma beams in Chapter 6, and Landau damping in Chapter 7 to the complete dispersion relation for an infinite hot plasma in a uniform magnetic field in Chapter 8. Chapter 9 contains many special cases of interest following from the general dispersion relations, and the last chapter deals more broadly with propagation through inhomogeneous plasma.

No text is perfect and one can, with difficulty, find some small objections. Equations are referred to in the fashion illustrated by (2–11) where 2 identifies the chapter and 11 the equation number in that chapter. Unfortunately, the equations themselves are followed by the second number only; and the chapter numbers are not displayed at the top of each page. This leads to unnecessary page thumbing in referring back. One might also wish that some of the derivations were a little less condensed. This will not trouble the expert but will make the text somewhat difficult for all but the brightest students. Finally, a little more discussion of the eigenmodes associated with the many interesting waves which are treated would have been welcome.

The minor nature of these objections only serves to point up the generally excellent quality of the book. This volume will surely prove to be an invaluable reference text for the worker in this field. It is a most welcome addition to the plasma physics literature.

ALBERT SIMON

(About the Reviewer: The author of this review is the Head of the Plasma Physics Division, John Jay Hopkins Laboratory for Pure and Applied Science, General Atomic Division of General Dynamics Corporation. He is also currently the Vice-Chairman of the Plasma Physics Division of the American Physical Society. Simon was at the Oak Ridge National Laboratory from 1950 to 1961 and was closely associated with the fusion project there. He is the author of An Introduction to Thermonuclear Research, *Pergamon Press, London (1959).)*

Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy. Course 15: Nuclear Spectroscopy. Edited by G. RACAH. Academic Press, 1962. 269 pp., $9.00.

If one combines Greek origin of the word school, viz. "schole" meaning leisure, with the more familiar definition of the term, then the learning amid pleasure which must have taken place on the shores of Lake Como from June 20 through July 9, 1960 can be pictured. This book is a summary of the material presented in the course and is organized as the course is into six long review papers and six shorter "seminars" which deal with particular aspects of the subject of Nuclear Spectroscopy. The editor of the volume is G. Racah of Hebrew University who also functioned as the director of the course. The papers of uniformly high caliber are necessarily brief, and thus require that the reader have previous knowledge of some nuclear physics, such as might be received on the graduate level or at the end of a comprehensive quantum mechanics course.

The introductory lesson, entitled "Mathematical Techniques" was given by Professor Racah, who modestly refrained from using the term "Racah algebra" for the work. This chapter begins with the formal rules for the coupling of angular momenta and applies them to a calculation of the energy matrix with additional sections devoted to the concepts of seniority and isotopic spins.

The next two chapters which introduce the reader to seemingly opposing yet complementary points of view concerning the structure of the nucleus, the independent particle model and the collective model, were presented by two of the foremost practitioners of these theories, respectively, I. Talmi of the Weizmann Institute, Rehovoth, and B. Mottelson, NORDITA, Copenhagen. Talmi presented calculations to show that the inclusion of an appropriate two-body potential enabled one to calculate the position of the energy levels of a variety of nuclei. Mottelson in his relatively long article (56 pages) demonstrates how a succession of two-body interactions results in collective oscillations. The wave functions corresponding to a nonspherical potential are described and energy levels calculated with them compared with various known level structures of nuclei. Finally, for the special case of the spectra of even–even nuclei, where the first excited (2+) state lies with roughly constant energy separation above the ground state, an interpretation in terms of the creation and annihilation operators of quantum field theory is made, in analogy with the Bardeen–Cooper–Schrieffer explanation of the energy gap in superconductors.

The next chapter, by G. Alaga of the University of Zagreb, is a fine exposition of the theory of beta decay beginning with the Fermi assumption of the scalar Dirac interaction potential and the five categories of possible forces, including both parity conserving and nonconserving ones. The application of beta decay results to nuclear spectroscopy was discussed. Finally, an excellent appendix on the Dirac equation especially as related to beta decay theory was presented. The subsequent chapter by G. Morpurgo of the University of Firenze, entitled "Selected Topics in the Theory of Electromagnetic Properties of Light Nuclei" is a less satisfying paper, mainly because of its brevity. The final long paper by J. Goldstone of CERN presents the formal theory of nuclear matter in as reasonable a manner as possible in the limited space available.

The second half of the book contains papers averaging nine pages each, which are intended to supplement the longer articles. The authors and titles are the following: H. Daniel, Max Planck Institute, Heidelberg, "Techniques in β-Decay Experiments"; E. Hayward, National Bureau of Standards, Washington, "Nuclear Photoeffect in Deformed Nuclei"; H. D. Holmgren, Naval Research Lab., Washington, "Interactions of He^3 and T^3 with Light Nuclei"; S. Jha, Tata Institute, Bombay, "Course in Nuclear Spectroscopy"; D. Tadic, Institute "Ruder Boskovic," Zagreb, "Pseudo-Scalar Interaction in the β-Decay of Pr^{144}"; and I. Unna, Weizmann Institute, Rehovoth, "M1-Transitions in N^{14}." These papers vary widely in quality but were not the main purpose of the course and due to their subordinate nature would not be the major interest of the purchase of this book, and will not be commented upon.

It is rather unlikely that the typical spectroscopist or physicist in general would fully benefit from exposure to a